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(51) INT CL⁷

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(56) Documents Cited

GB 2334276 A GB 2327691 A GB 2307932 A

(58) Field of Search

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Online: EPODOC, JAPIO, WPI

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(54) Abstract Title

Window milling and measurement apparatus with bypass valve

(57) A one trip apparatus and method involves a bypass valve 22 operated in conjunction with an MWD tool in a bottomhole assembly. The milling system 14 for the window, the whipstock 10, and the anchor are run in together with the bypass valve 22 and MWD tool. The whipstock 10 is oriented using the MWD tool with circulation through the bypass valve 22. The bypass valve 22 is actuated to close and lock to allow subsequent setting of the packer or bridge plug once the whipstock 10 has been properly orientated. The bypass valve 22 is movably responsive to fluid flow in a first direction and in an opposite second direction under a biasing force preferably a spring 46. The milling system is supported to the whipstock between a pair of blocks 106, Fig 2b and the mere rotation of the mills allows for formation of the window as the lower block 106 is milled away. The milling system 14 is held to the whipstock 10 with pins 146, Fig 3a through blocks. The pins 146 are capable of handling greater shear loads than shear pins which have in the past been used to secure the mills to the whipstock.

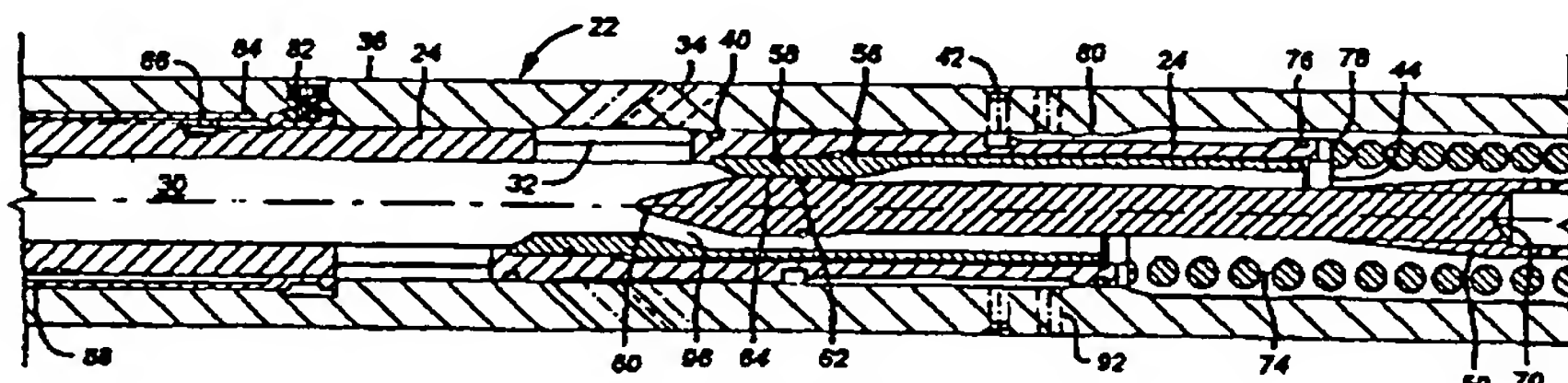


FIG. 1b

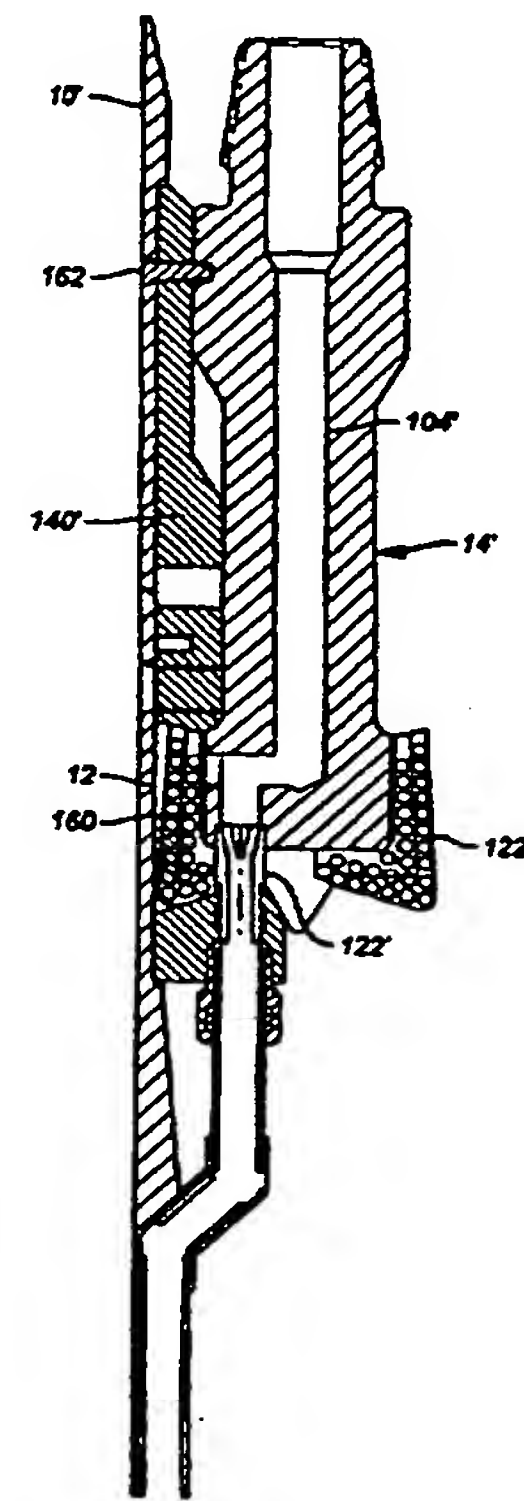


FIG. 4

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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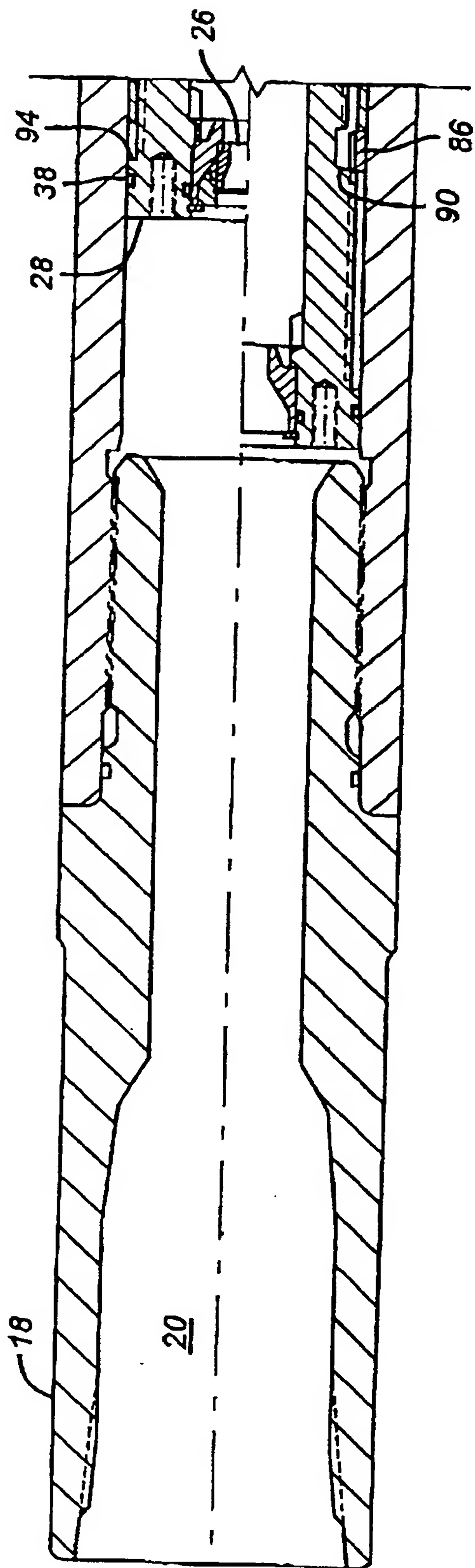


FIG. 1a

1/5

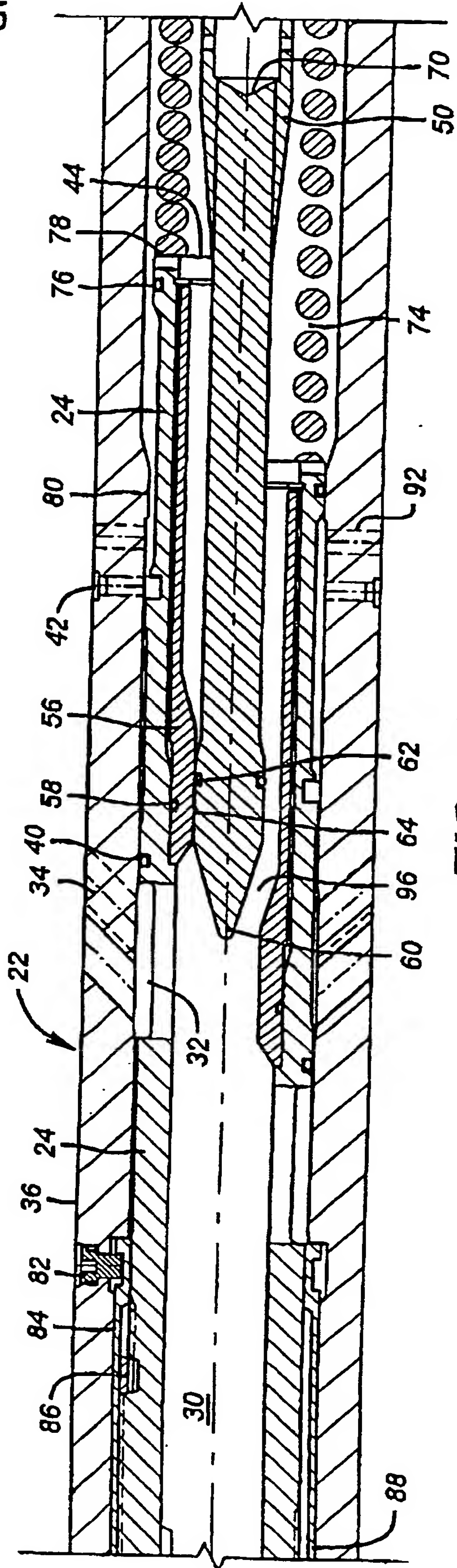


FIG. 1b

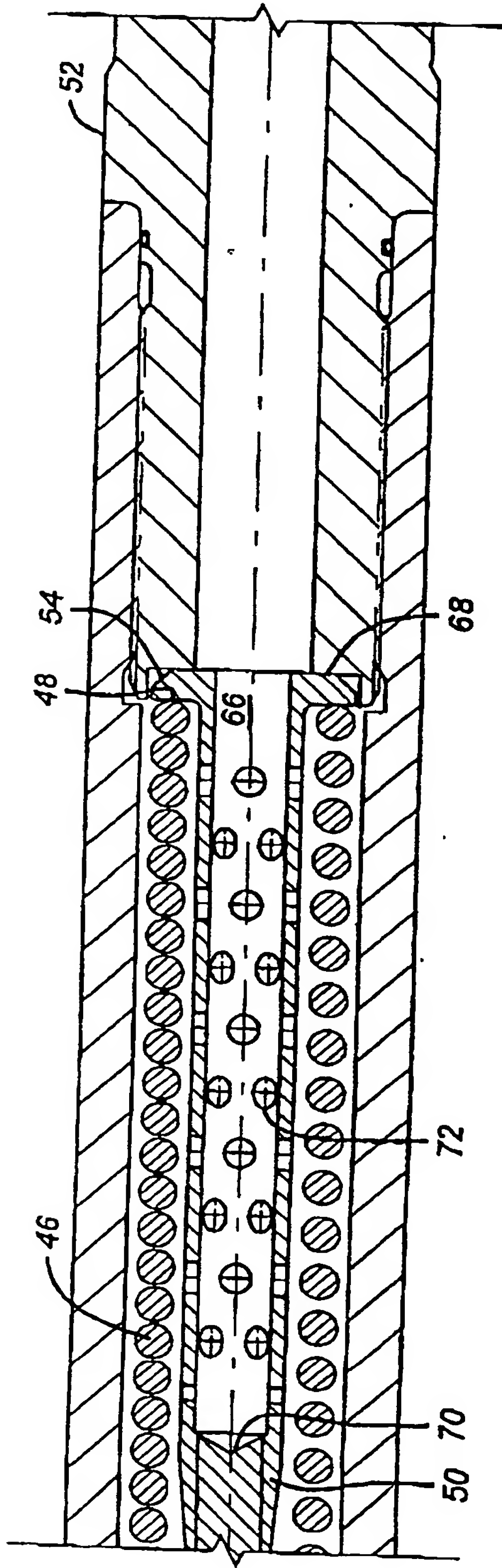


FIG. 1c

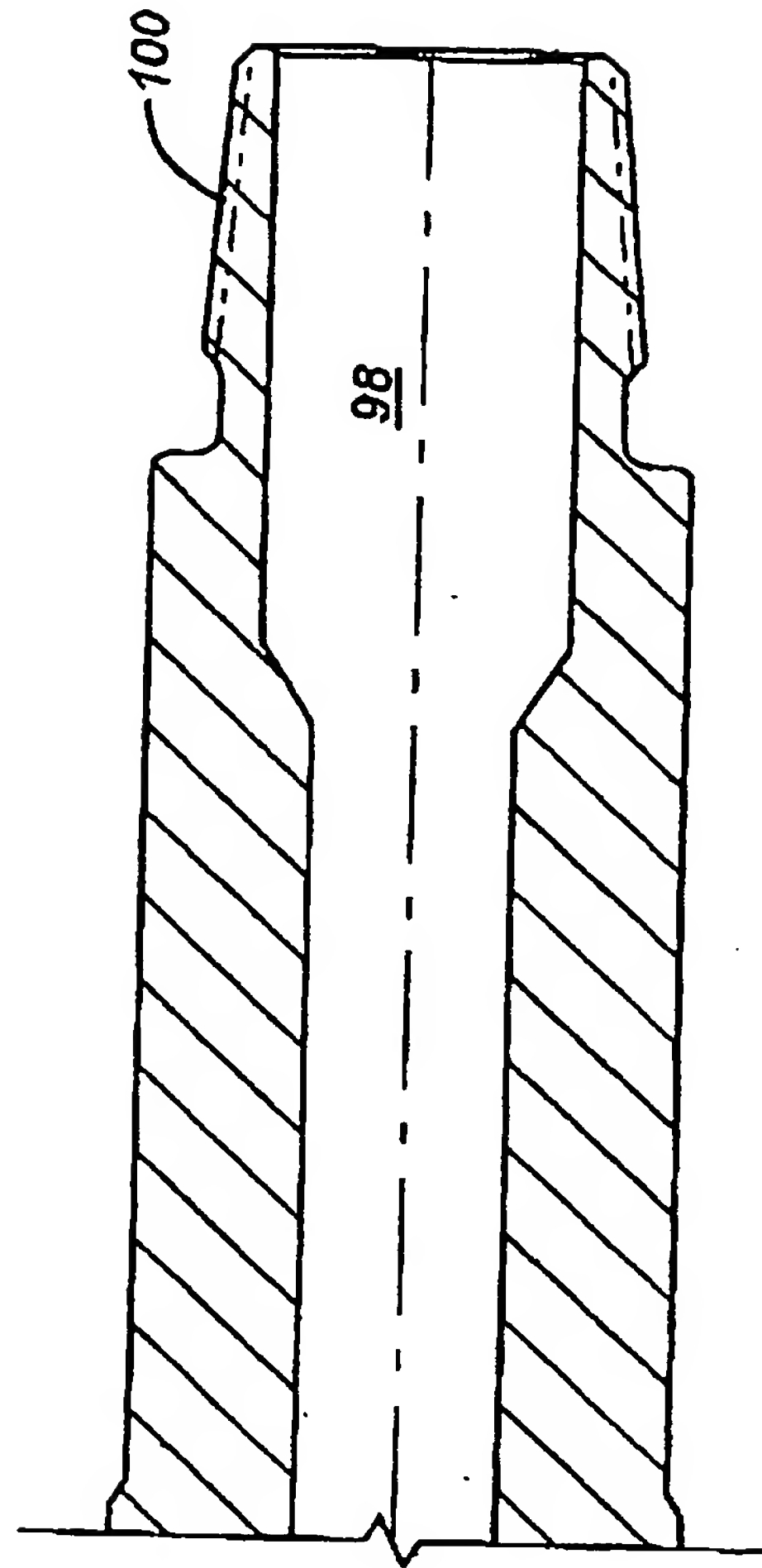


FIG. 1d

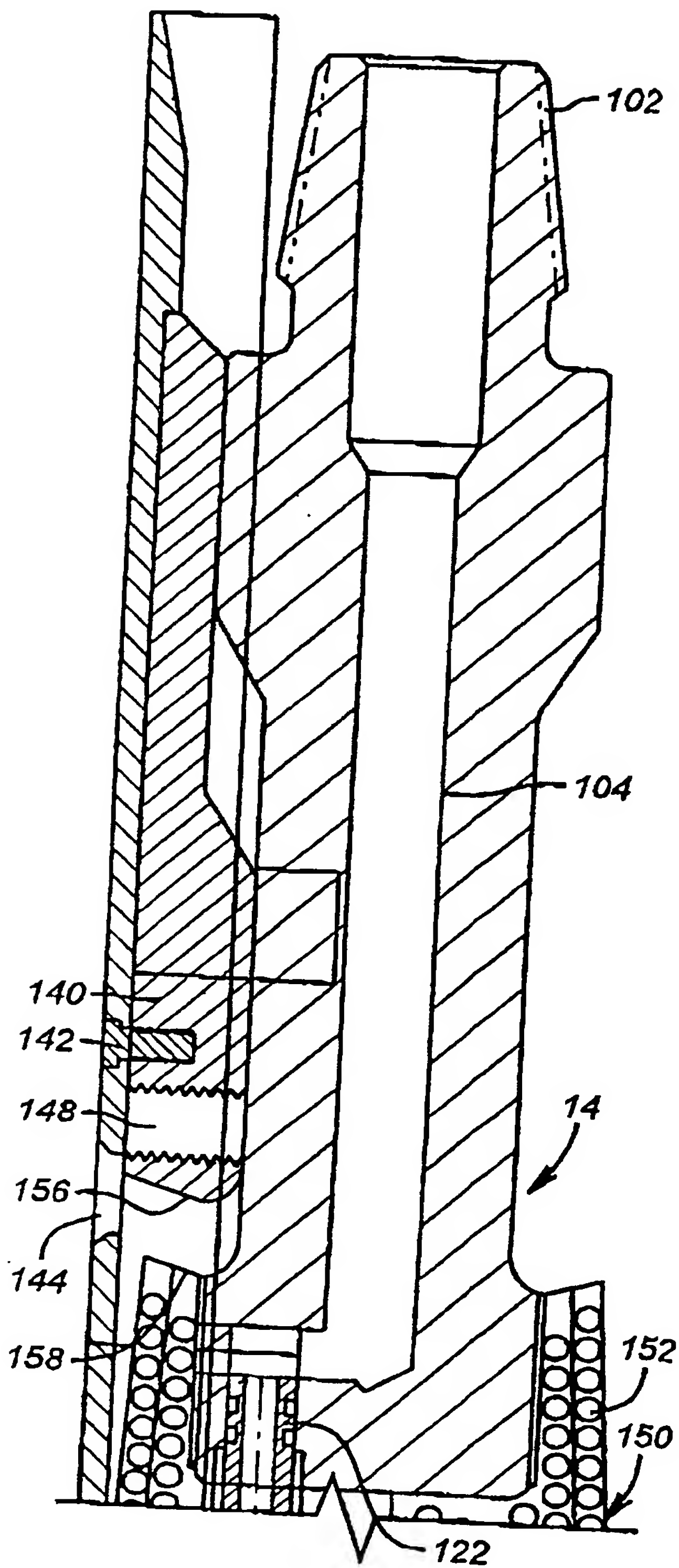


FIG. 2a

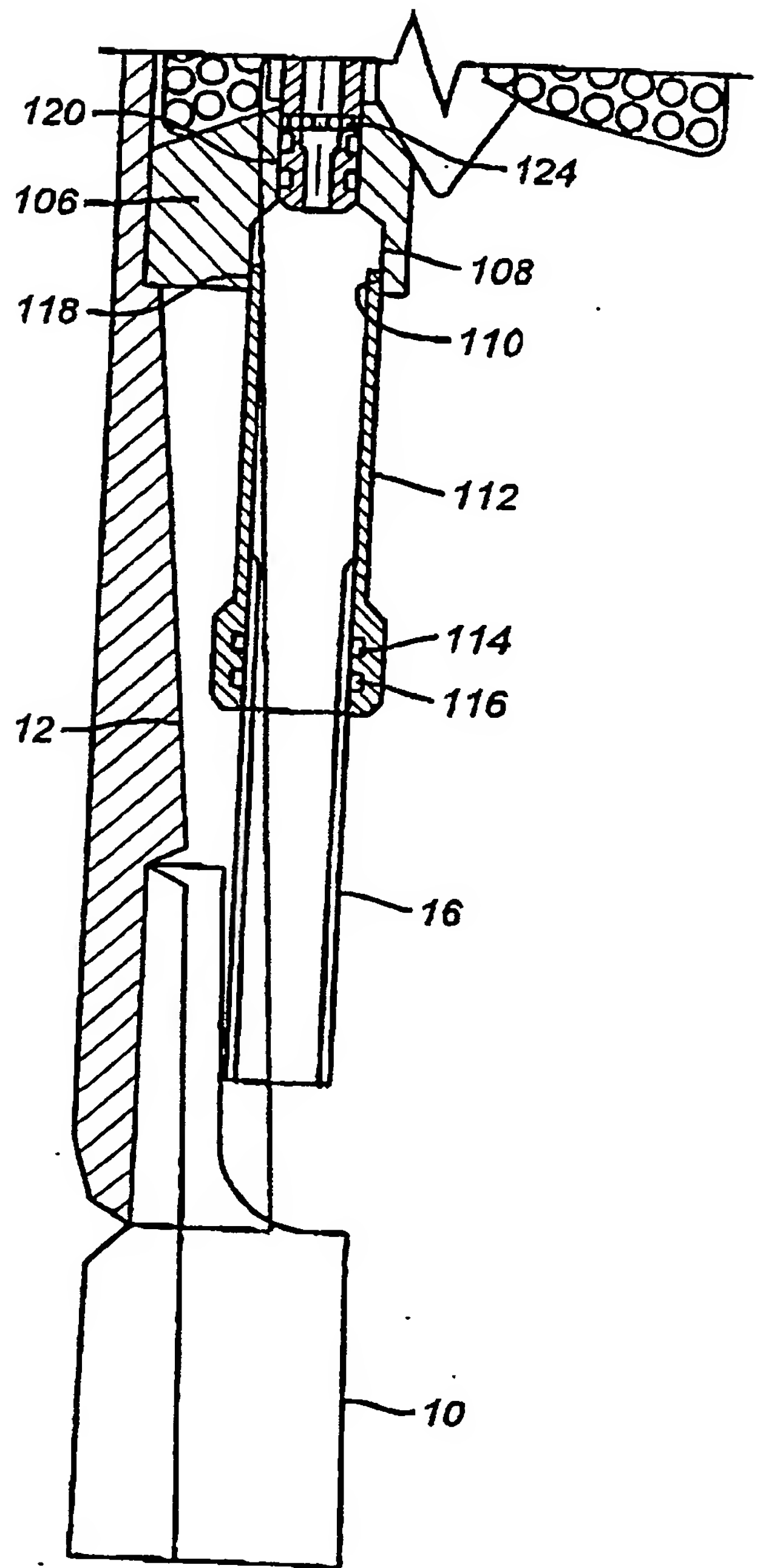
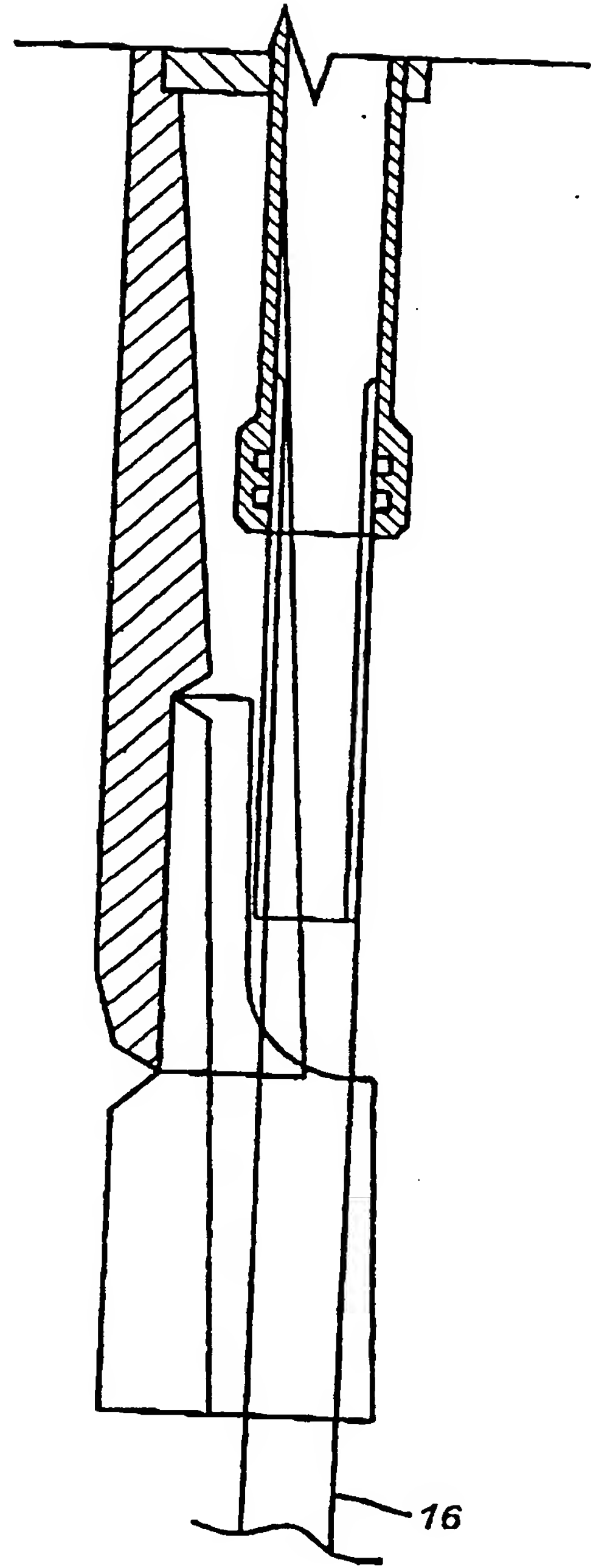
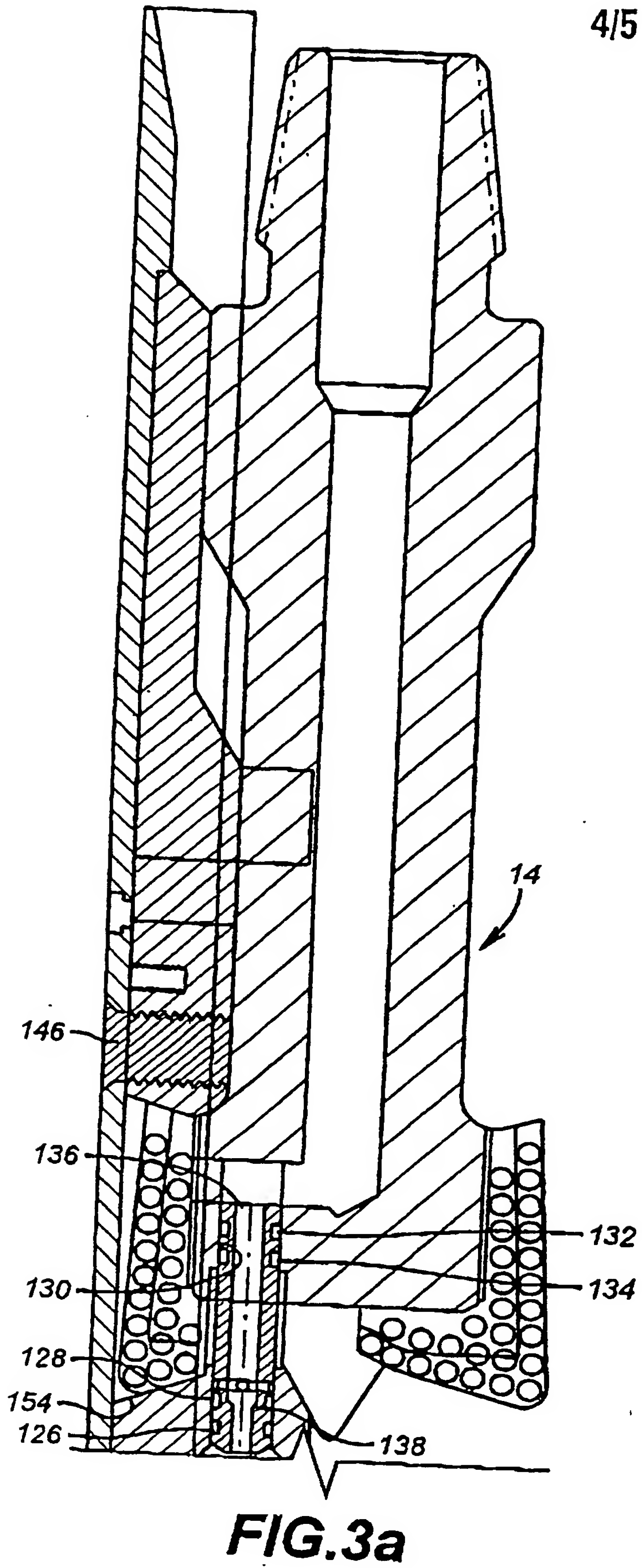


FIG. 2b



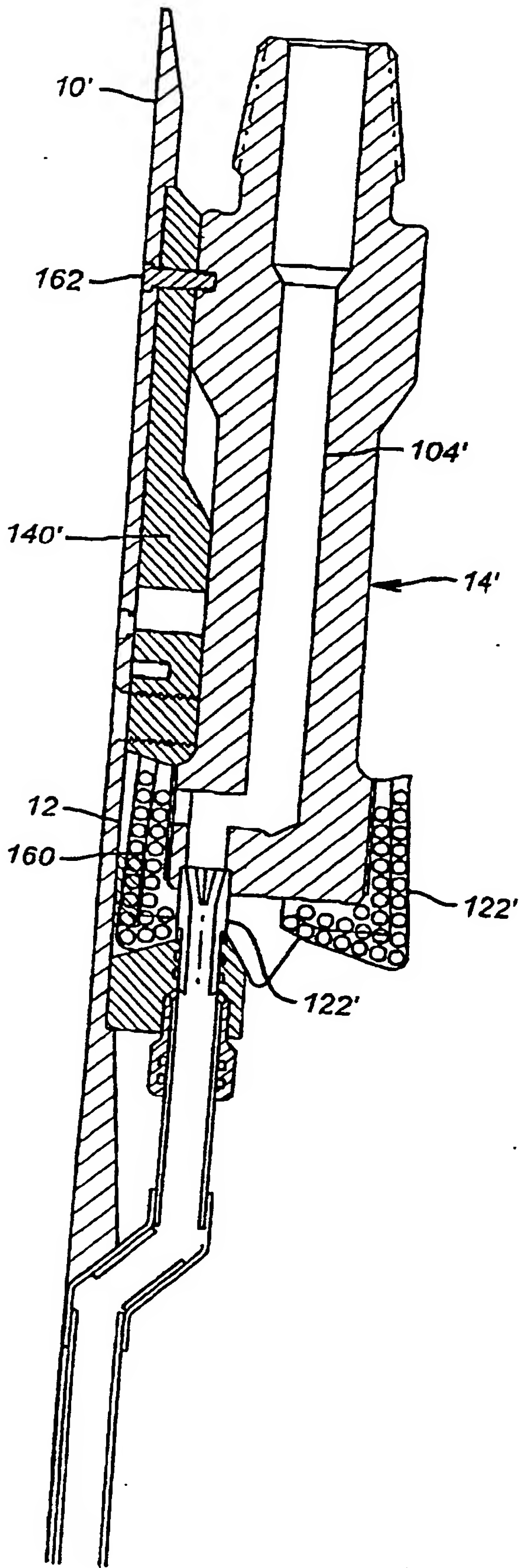


FIG. 4

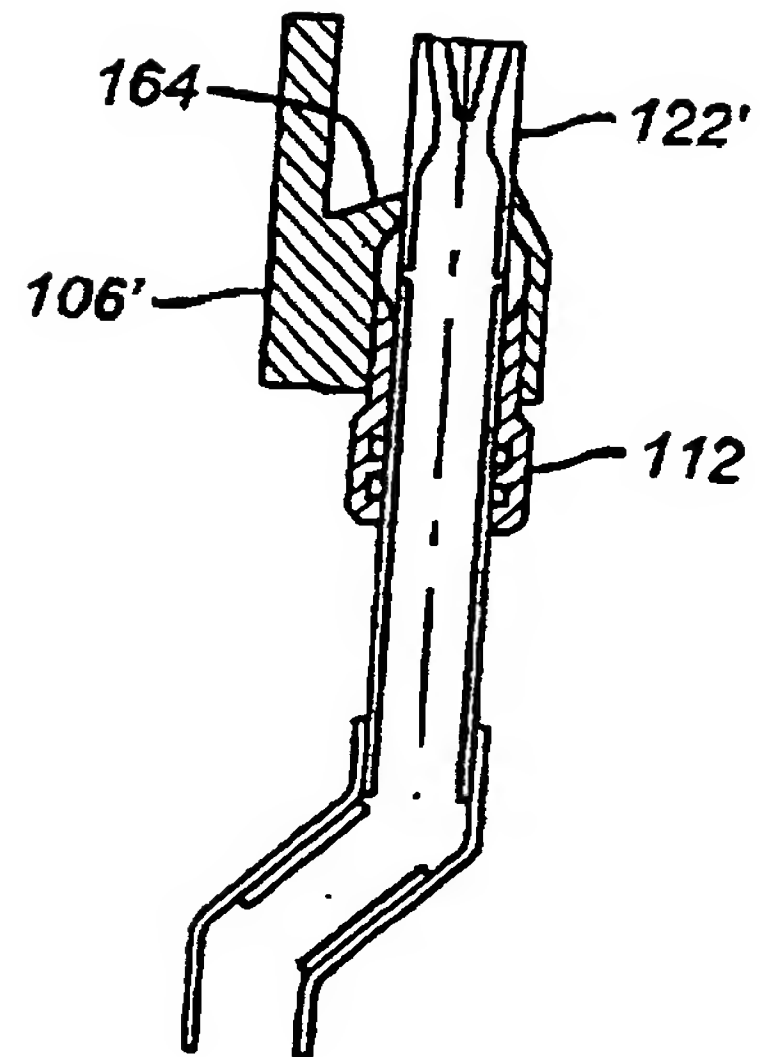


FIG. 5

2345934

**TITLE: ONE-TRIP WINDOW MILLING APPARATUS &
METHOD WITH MEASUREMENT-WHILE-DRILLING**

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FIELD OF THE INVENTION

The field of this invention relates to orienting a whipstock and milling a window in a single trip.

BACKGROUND OF THE INVENTION

When milling openings in casing for laterals from existing wellbores, saving rig time is of utmost importance. Systems have been evolving to cut down the time necessary for milling a window by designing equipment and systems to minimize the number of trips into the wellbore to mill the window. In the past, systems have been developed to attach the complete series of mills required to mill the window to the whipstock when running in to eliminate subsequent trips to change mills during the forming of the window. With these systems, once the whipstock was properly set in the wellbore, the mills were already there, attached to it, and the window could be milled in a single trip in the wellbore, which allowed the whipstock to be anchored and the window to be milled. U.S. Patent 5,109,924, invented by *Jürgens*, illustrates one such system.

Other systems have sought to incorporate the orientation step for the whipstock with at least initiating the milling procedure for the window. The technique involves the use of measurement-while-drilling (MWD) equipment in the bottomhole assembly when introducing the whipstock, its

support, and at least a starter mill for forming the window. However, the MWD equipment requires significant circulation rates, while the anchor or packer or bridge plug used to support the whipstock would normally require pressurization in order to be set. Thus, what has evolved is a combination bypass valve in the bottomhole assembly which permits high circulation through the MWD equipment for orientation of the whipstock. At the same time, this equipment, through the bypass valve closing, in turn allows pressurization for setting a packer, bridge plug or anchor once the desired orientation for the whipstock has been obtained.

One such device is illustrated in U.S. Patent 5,443,129, invented by *Bailey*. This design has several shortcomings. The bypass valve is in the bottomhole assembly as the lateral is being drilled. Each time another stand is added to the string for drilling the lateral, the bypass valve in *Bailey* strokes between open and closed. This characteristic can allow cuttings from the annulus to enter the circulation port each time it opens, thus potentially precluding it from reclosing so as to again permit circulation to go down to the bit. Without circulation down to the bit, any further drilling of the lateral is prevented. This situation, if undetected, can also lead to sticking the bit due to low or no circulation to take cuttings away from the bit. Another potential problem of the *Bailey* design is that a floating piston is used to separate the hydraulic setting mechanism of the packer from the circulation flowpath within the bypass valve. Thus, if blockages to circulation occur through the bypass valve, a pressure build-up on the floating piston can occur, setting the packer or bridge plug at an inopportune time.

Thus, one of the objects of the present apparatus and method is to be able to properly orient a whipstock, using a bypass valve in the bottomhole assembly where the setting system for the packer or bridge plug is effectively isolated from the circulation flowpath to avoid inadvertent settings of the packer or bridge plug which functions to anchor the whipstock. Yet another objective is to design a bypass circulation valve which, after obtaining the desired orientation of the whipstock, can close to circulation required for MWD operation and maintain the MWD circulation port in the closed position. This gives assurance during subsequent drilling of the lateral that the bypass valve will not stick in the bypass position, thus creating a potential for sticking the bit.

Traditionally, mills have been attached to the whipstock using a lug with a shearable connection to the milling assembly. This has created problems in the past because the shear pin holding the milling assembly to the lug might not release at the predetermined level of force indicated by the manufacturer. At times, in order to run in the bottomhole assembly, forces are applied which could result in an inadvertent premature release between the whipstock and milling assembly at this shear pin. Thus, another objective of the present invention is to improve the connection between the milling assembly and the whipstock so that the assembly could be run into the wellbore with a greater degree of comfort that a premature release will not occur. Thus, the objective of the new technique is to effectively sandwich in the starter mill to the whipstock to allow the use of sturdier connections to eliminate or reduce the risk of an inadvertent release during run-in. Release of the mill from the whipstock occurs simply by rotating the mill after releasing a rotational lock. These objectives will

be more readily appreciated by those skilled in the art from a review of the description of the preferred embodiment below.

SUMMARY OF THE INVENTION

A one-trip apparatus and method involves a bypass valve operated in conjunction with an MWD tool in a bottomhole assembly. The milling system for the window, the whipstock, and the anchor are run in together with the bypass valve and MWD tool. The whipstock is oriented using the MWD tool with circulation through the bypass valve. The bypass valve is actuated to close and locks closed to allow subsequent setting of the packer or bridge plug once the whipstock has been properly oriented. The mills are supported to the whipstock between a pair of lugs and rotationally locked to one of the lugs. Pressure at a predetermined level releases the rotational lock and mere rotation of the mills allows for formation of the window as the lower lug is milled away. The mills are held to the whipstock with pins through the blocks which are capable of handling greater shear loads than shear pins which have in the past been used to secure the mills to the whipstock.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1a-d are a sectional elevation in split view of the bypass valve to be mounted below the MWD equipment in a bottomhole assembly, showing the bypass and flow through positions.

Figures 2a-b are a sectional elevation showing the milling assembly as it is being sandwiched between lugs connected to the whipstock.

O-ring 40 is also mounted between the piston 24 and body 36 adjacent port 32.

A shear pin 42 secures the piston 24 to the body 36 during run-in. Piston 24 has a lower end 44 (see Figure 1b) on which spring 46 provides an upward bias. Spring 46 is supported from surface 48 of choke plug 50. Choke plug 50 rests on bottom sub 52 and is held against it at surface 54 due to the reaction force to spring 46.

Piston 24 has a choke sleeve 56 which is mounted within bore 30 of piston 24. The choke sleeve 56 is connected to the piston 24 for tandem movement. O-ring 58 seals between the piston 24 and choke sleeve 56. Bore 30 in piston 24 is obstructed by closed end 60 of choke sleeve 56. O-ring 62, when in contact with surface 64 on choke sleeve 56, effectively seals off bore 30 for the run-in position. The run-in position incorporates alignment of ports 32 with outlet ports 34. Choke sleeve 56 also has a bore 66 which begins at its lower end 68 and extends to an upper end 70. In between ends 68 and 70 are a plurality of openings 72 which allow flow from annular space 74 to exit through bore 66 by passing through openings 72. The necessary movements to allow such flow to occur will be described below.

Piston 24 has an O-ring seal 76 adjacent its lower end 78. Body 36 has a raised surface 80 with which seal 76 comes in contact upon movement of piston 24, as shown in a portion of Figure 1b.

Attached to body 36 by pin or pins 82 is a collet sleeve 84. A snap ring 86 is carried by piston 24 against collet sleeve 84. Ultimately, as shown in Figure 1a, the snap ring 86 straddles the top end 88 of collet

sleeve 84 while engaging sleeve 24 at surface 90, thus locking in upward movement of the piston 24 as will be described below.

Body 36 also has a series of openings 92 which permit outward fluid displacement from body 36 as piston 24 is stroked upwardly. The presence of openings 92 also prevents surges of pressure to the packer or bridge plug or anchor below (not shown) as the piston 24 strokes upwardly, bringing O- ring 76 in contact with surface 80.

The major components of the bypass valve now having been described, its operation will be reviewed in greater detail. The bypass valve 22 is run in with the piston 24 in the down position, compressing spring 46 and being held in that position by pin or pins 42. With the piston 24 in that position, the ports 32 line up with outlet ports 34 to allow circulation from the surface through the MWD tool (not shown) and into passage 20. Thereafter, flow goes through the nozzle 26 into bore 30. Thereafter, the flow exits ports 32 into outlet ports 34 and into the annulus for a return to the surface. Closed end 60, due to the O-ring seal 62 being disposed against surface 64, effectively closes off the lower end of bore 30. Once the proper orientation for the whipstock 10 has been obtained, flow is increased through passage 20 which creates an incremental downward force through nozzle 26 on piston 24. Eventually, that force rises to a predetermined level to break the shear pins 42. Piston 24 can move down only until shoulder 94 (see Figure 1a) hits the top end 88 of collet sleeve 84. This downward movement causes a partial misalignment between ports 32 and outlet ports 34. This is seen as a pressure increase at the surface to allow surface personnel to know that the shear pins 42 have

broken. There after, the rig pumps are turned off, now allowing spring 46 to bias the piston 24 and with it, choke sleeve 56, in an upward direction. Since choke plug 50 remains stationary, surface 64 moves away from O-ring 62 to clear a passage 96 around closed end 60. As passage 96 is developing due to relative movement between the choke plug 50 and the choke sleeve 56, O-ring 76 is moving closer to surface 80. Fluid is thus being displaced out of openings 92 to prevent a surge of pressure to the packer or bridge plug or anchor (not shown) upon initial movement of the piston 24. Upon sufficient upward movement of the piston 24, O-ring 40 crosses outlet ports 34 and O-ring 76 contacts surface 80. Outlet ports 34 are now effectively sealed off by virtue of O-ring seals 40 and 76. The snap ring 86 snaps radially outwardly above the top end 88, straddling it and engaging at the same time surface 90 on piston 24, thus preventing any return movement of the piston 24 once fully stroked to the closed position. Once all the above-described movements have occurred, the pumps are turned on at the surface and flow resumes through passage 20 down passage 96 into annular space 74. From there, the flow passes through openings 72 into bore 66 and out through passage 98 in bottom sub 52. Bottom sub 52 has threads 100. Connected to threads 100 are connectors (not shown) which ultimately secure the bottom sub 52 to threads 102 (see Figure 2b) of the milling system 14. Passage 98 and bottom sub 52 continue as passage 104 in the milling system 14.

Referring now to Figures 2a and b, the guide surface 12 of the whip stock 10 has a lower block 106 which is preferably made of brass, solidly secured to it. Lower block 106 has a lower bore 108 which has a thread 110. Tube 16 has a sliding sleeve 112 which is movable with respect to

tube 16 and is sealingly attached to it by virtue of O-rings 114 and 116. Sliding sleeve 112 has a thread 118 which can be engaged to thread 110 of lower block 106. Lower block 106 has an upper bore 120 adjacent lower bore 110. With the telescoping sleeve 112 in a down position, tube 122 can be inserted from lower bore 108 into upper bore 120 and its position can be secured to the lower block 106 through a shear pin 124. Thus, in the position shown in Figure 2, sleeve 122 is sealingly secured in bore 120 of lower block 106 by virtue of O-ring seals 126 and 128. Sleeve 122 is also secured in bore 130 of the milling system 14 by virtue of O-ring seals 132 and 134.

Sleeve 122 has an internal bore 136 which narrows at taper 138. Thus, with the sleeve 122 extending both into bore 120 of lower block 106, as well as bore 130 in the milling system 14, the milling system 14 is rotationally locked to the whipstock 10 since the lower block 106 is fixedly mounted to the guide surface 12. However, the rotational lock can be released upon sufficient flow through passage 104. In view of taper 138, a sufficiently large unbalanced force is eventually created against the shear pin 124, which allows it to break. Thereafter, again because of taper 138, the sleeve 122 is propelled downwardly and retained within sliding sleeve 112. The downward movement of sleeve 122 brings it out of bore 130, thus releasing the rotational lock between the milling system 14 and the whipstock 10.

The whipstock 10 also has a movable upper block 140 which is secured to the guide surface 12 initially by a fastener 142. The whipstock 10 has an opening 144 which can accept a stud 146 when a threaded passage 148 is brought into alignment with it. Accordingly, when the

milling system 14, which has a plurality of cutting blades 150, each of which has a plurality of inserts 152 disposed in a known manner, is to be connected to the whipstock 10, one of the blades 150 is brought down in contact with sloping surface 154 on lower block 106. Fastener 142 is removed, allowing upper block 140 to descend until threaded passage 148 is in alignment with opening 144. At that point, bolt or stud 146 is inserted and secured into upper block 140, thus not only securing the position of upper block 140 to the whipstock 10 but also at the same time sandwiching in the blade 150 as sloping surface 156 on the upper block 140 engages the top sloping surface 158 on the blade 150. In the position shown in Figures 3a and b, the milling system 14 is firmly secured through the blade 150 between the upper block 140 and lower block 106. In order to set the packer, bridge plug or anchor (not shown), the bypass valve 22, shown in Figure 1, must be put in the position where outlet ports 34 are closed. A subsequent pressure build-up will initiate flow to the packer through tube 16. When the flow increases to a predetermined level, the shear pin 124 is broken, allowing the sleeve 122 to come out of bore 130. At that point, the rotational lock between the milling system 14 and the whipstock 10 is released. Rotation of the milling system 14 by whatever means can then begin. As rotation begins, the lower block 106 is milled away and the guide surface 12 directs the milling system 14 into the adjacent casing to mill the window and lateral in the known manner.

The advantage of this system is that the use of shear pins to retain the milling system 14 to the whipstock 10 is eliminated. Instead, a solid screw, stud or bolt 146 is used whose ability to withstand shear loading is substantially higher than normally used shear pins. Sleeve 122 is also a

robust rotational lock which facilitates manipulation of the bottomhole assembly for run-in. Thus, if manipulation of the bottomhole assembly is required for run-in, there is little or no risk of a premature release in the manner in which the milling system 14 is retained to the whipstock 10. Raising or lowering is also unnecessary to release the milling system 14 from the whipstock 10. The milling system 14 is merely rotated as the bottom block 106 is milled away and the milling of the window proceeds in the known manner.

Figures 4 and 5 illustrate alternative embodiments to secure the milling system 14_. In the Figure 4 design, the sleeve 122_ is made relatively weak, and the principal resistance to applied torque is provided through a tab or tabs 160, which engages one of the cutting blades 150_. The tab 160 can be connected to the guide surface 12_. It can be used in conjunction with a torsion bolt 162 which extends through upper block 140_. With the sleeve being made of a fairly thin material in the Figure 4 embodiment, release from the whipstock 10_ can still be accomplished if for any reason the sleeve 122_ does not get expelled in the manner previously discussed. The sleeve 122_ can be made of sufficiently thin material so that flow through passage 104_ can simply erode it, or alternatively the milling system 14_ can be simply rotated to break the sleeve 122_ along with tab 160, if used, and/or torsion bolt 162, if used. Figure 5 illustrates an alternative embodiment for the lower block 106_, indicating that a projecting segment 164, which houses the sliding sleeve 112_, can be made in such a manner that rotation of the milling system 14_ will simply snap off the extending segment 164 off the lower block 106_ at

a predetermined torque value to allow the milling of the casing to make the window. Thus, in both embodiments in Figures 4 and 5, the sleeve 122_ can be made sufficiently weak so that it can either be eroded away or sheared cleanly by initiation of rotation of the milling system 14_. This is to be contrasted with the embodiment of Figures 2 and 3, where the sleeve 122 is the principal rotational lock and, therefore, must be expelled out of the way to facilitate release of the milling system 14. The system of Figures 4 and 5 provides a different way to rotationally lock the milling system 14_ by use of either a tab 160 secured to the guide surface 12_, used alone or in conjunction with a torsion bolt or bolts 162 which provide the principal rotational lock. The sleeve 122_ may also offer some minimal rotational resistance, but in the embodiment of Figure 4 is reasonably weak so that it can be sheared off with rotation of the milling system 14_. In the embodiment of Figure 5, the level of resistance to applied torque is determined by the design of the lower block 106_ and the area of the ultimate shear plane as the extending segment 164 is sheared off the portion of the lower block 106_ which is, in turn, secured to the guide surface 12_.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

Claims

5 1. A valve assembly for downhole use comprising:

 a body having a passage therethrough and a lateral
port;

10 a valve member movable from an open position where
said passage below said lateral port is obstructed and
said lateral port is open, to a closed position where
said lateral port is closed and said passage below said
lateral port is open;

15 said valve member locking upon reaching said closed
position.

20 2. The valve assembly of claim 1, further comprising:

 a vent opening in said body to allow for fluid
displacement therethrough as said valve member moves
toward its said closed position, said vent opening being
obstructed by said valve member in said closed position.

25 3. The valve assembly of claim 1, wherein:

 said valve member is movably responsive to fluid
flow in a first direction and in an opposite second
30 direction under a biasing force.

4. The valve assembly of claim 3, wherein:

 said valve member when moving in said first
35 direction obstructs, at least in part, said lateral port

while maintaining said passage below said lateral port closed thus causing a pressure buildup in said body as an indication of movement of said valve body in said first direction.

5

5. The valve assembly of claim 4, wherein:

said valve member is initially retained against a spring bias by a breakable member;

10

said valve member comprises a passage having a flow restriction;

15

said body comprises a plug which obstructs said passage in said valve member in said closed position;

20

whereupon sufficient flow induced force on said valve member, said breakable member breaks as said valve member moves to at least partially obstruct said lateral port, whereupon removal of said flow induced force on said valve member said spring moves said flow passage in said valve member away from said plug which opens said passage in said body below said lateral port and moves ____ said valve member over said lateral port.

25

6. The valve assembly of claim 5, further comprising:

30

a vent opening in said body to allow for fluid displacement therethrough as said valve member moves toward its said closed position, said vent opening being obstructed by said valve member in said closed position;

said body comprising a springing lock to secure said valve member to said body in said closed position.

35

7. In a one trip window milling assembly which comprises an orientation tool, at least one mill, a whipstock, a pressure activated anchor and a bypass valve which selectively allows circulation for operation of the orientation tool and for the direction of pressure to said anchor to activate it, the improvement in said valve comprising:

10 a body having a passage therethrough and a lateral port;

15 a valve member movable from an open position where said passage below said lateral port, extending to said anchor, is obstructed and said lateral port is open, to a closed position where said lateral port is closed and said passage below said lateral port extending to said anchor is open;

20 said valve member locking upon reaching said closed position.

8. The valve assembly of claim 7, further comprising:

25 a vent opening in said body to allow for fluid displacement therethrough as said valve member moves toward its said closed position to prevent pressure buildup on said anchor, said vent opening being obstructed by said valve member in said closed position.

30 9. The valve assembly of claim 7, wherein:

said valve member is movably responsive to fluid flow in a first direction and in an opposite second direction to a biasing force.

10. The valve assembly of claim 9, wherein:

5 said valve member when moving in said first direction obstructs, at least in part, said lateral port while maintaining said passage below said lateral port closed thus causing a pressure buildup in said body which pressure buildup is isolated from said anchor, as an indication of movement of said valve body in said first direction.

10

11. The valve assembly of claim 10, wherein:

 said valve member is initially retained against a spring bias by a breakable member;

15

 said valve member comprises a passage having a flow restriction;

20 said body comprises a plug which obstructs said passage in said valve member in said closed position to isolate said anchor from applied pressure;

25 whereupon sufficient flow induced force on said valve member, said breakable member breaks as said valve member moves to at least partially obstruct said lateral port, whereupon removal of said flow induced force on said valve member said spring moves said valve member away from said plug which opens said passage in said body below said lateral port to said anchor and moves
30 said valve member over said lateral port.

12. The valve assembly of claim 11, further comprising:

35 a vent opening in said body to allow for fluid displacement therethrough as said valve member moves

toward its said closed position to prevent pressure buildup on said anchor, said vent opening being obstructed by said valve member in said closed position;

5 said body comprising a springing lock to secure said valve member to said body in said closed position.

13. A rotational lock system to secure a mill to a whipstock comprising:

10

 a lug having a passage therethrough secured to the whipstock;

15

 a tube extending from a flow passage in the mill and into said passage in said lug;

 said tube selectively displaceable out of said flow passage in the mill to rotationally release said mill.

20

14. The system of claim 13, wherein:

 said lug contacts said mill from below and a retainer is mounted to said whipstock opposite said lug__ to retain said mill longitudinally to said whipstock.

25

15. The system of claim 14, wherein:

 said retainer is secured to said whipstock by a stud or bolt.

30

16. The system of claim 13, further comprising:

35

 a telescoping conduit selectively securable to said passage in said lug, said conduit configured to retain said tube after it is expelled from said lug.

17. A rotational lock system to secure a mill to a
whipstock comprising:

5 a lug having a passage therethrough secured to the
whipstock;

a tube extending from a flow passage in the mill
and into said passage in said lug.

10 said tube is made of a sufficiently thin wall so
that it can be eroded with flow going through it or
sheared apart by mill rotation; and

15 a tab mounted to said whipstock engaging said mill
to resist rotation.

18. The system of claim 17, further comprising:

20 a retainer to secure said mill against said lug,
said retainer secured to said whipstock by a bolt or
stud.

19. The system of claim 18, wherein:

25 said tab, said lug and said tube, if it still
extends from said mill into said lug, are removed by
operation of said mill.

30 20. A rotational lock system to secure a mill to a
whipstock comprising:

a lug having a passage therethrough secured to the
whipstock;

35 a tube extending from a flow passage in the mill

and into said passage in said lug.

5 said passage in said lug is disposed on a
projecting segment thereof disposed away from said
whipstock, such that rotation of said mill separates
said protecting segment from the balance of said lug.

10 21. A window milling assembly comprising a mill and a
whipstock, wherein the mill is retained longitudinally
between a pair of lugs connected to the whipstock, and
wherein the mill is retained rotationally by a
releasable lock connected to the whipstock, such that on
release of the lock the mill can rotate to allow
formation of a window as the lower lug is milled away.



INVESTOR IN PEOPLE

Application No: GB 0001480.3
Claims searched: 1-12

Examiner: Matthew Parker
Date of search: 8 May 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.R): E1F: FLF, FLP
Int Cl (Ed.7): E21B: 21/10, 34/10, 34/16
Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2334276 A SCHLUMBERGER LTD	1-2
X	GB 2327691 A SMITH INTERNATIONAL INC	1-3
X	GB 2307932 A THE RED BARON LIMITED	1-4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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